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1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

SEASONAL DISTRIBUTION OF "MACROLEPIDOPTERA" IN SANTA CLARA COUNTY, CALIFORNIA

PAUL A. OPLER and J. S. BUCKETT

University of California
Berkeley, California

University of California
Davis, California

This study was undertaken to delineate the features of flight periodicity of nocturnal "Macrolepidoptera" at New Almaden, Santa Clara County, California, during a single calendar year. This area lies to the east of the Santa Cruz Mountains of coastal Central California. Additionally, a comparison of the macrolepidopterous fauna of New Almaden with that of four other sites in California and Oregon is made.

METHODS

During 1964, moths were collected by Opler on 150 nights at New Almaden, Santa Clara County, California. The number of collecting nights was not disproportionate during any one month. The highest number of nights was for February (16), while the lowest number was for December (7). The number of collecting nights for the other months ranged from 10 to 15. The longest period in which no sampling was conducted was 11 days. The amount of time spent collecting per night was not equal, and the time of night was not always the same. Usually collections were made from dusk to about 11:30 P.M.

Moths were attracted to a 15 Watt unfiltered Ultra-Violet light fixture suspended over a vertical white sheet and collected individually from the sheet. Subsequently, most individuals were determined by Buckett. Finally, the collection was deposited in the entomology collection at San Jose State College.

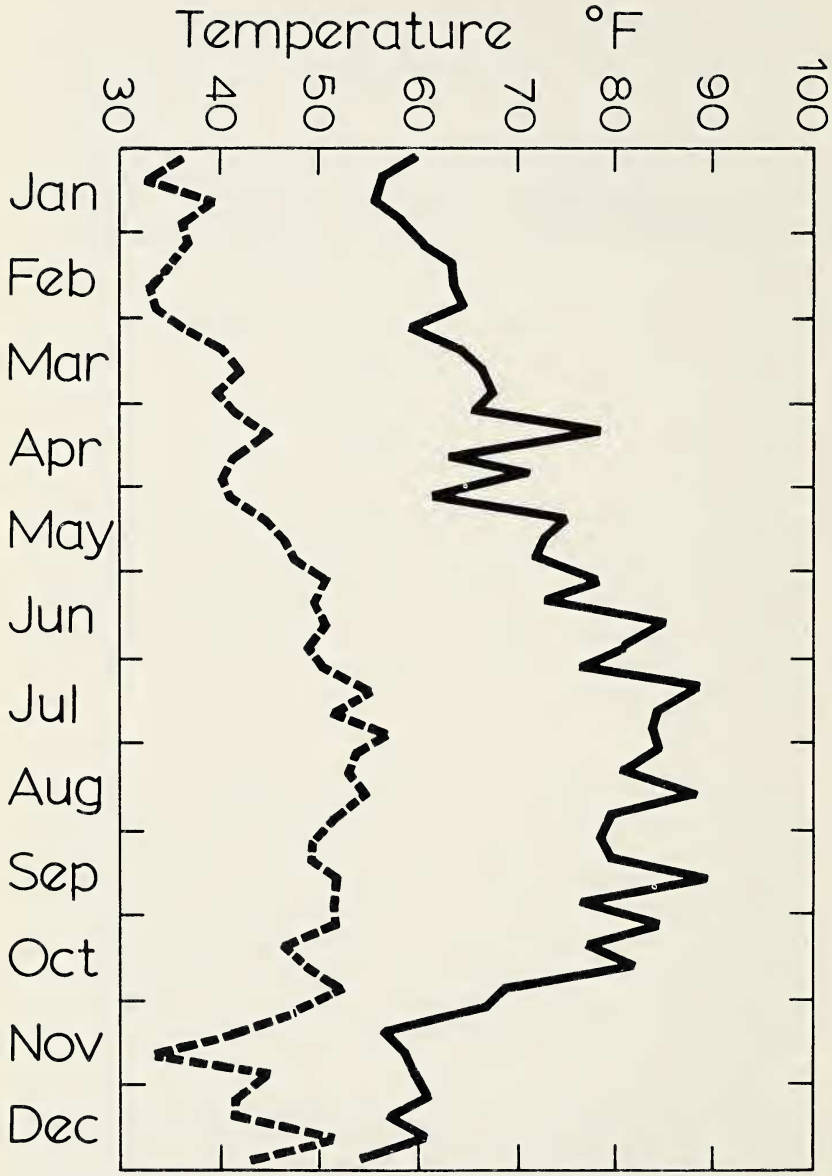


Fig. 1.—Fluctuations of weekly maximum and minimum temperatures for 1964 at Los Gatos, Santa Clara County, California.

STUDY SITE

The study site was the Opler residence at 20861 Almaden Road, New Almaden, Santa Clara County, California. This site was adjacent to a grove of mature coast live oaks (*Quercus agrifolia* Neé) at the base of an east-facing slope. To the west was an undisturbed area of oak woodland and coastal chaparral (this area has been subjected to overgrazing since the study was completed). Immediately to the east was a small orchard composed of a wide variety of fruit trees (unsprayed for 20+ years), while further to the east was a permanent creek and a west-facing slope of grassland.

The geology of this area was described in detail by Atkinson (1942). All surface formations of the area belong to the Franciscan Formation which is of Jurassic Age. The east-facing slope is of a sandstone base, while the west-facing slope is the edge of an extensive serpentine outcrop.

Conspicuous perennial floral elements show that the area is ecotonal between the Californian and Oregonian Biotic Provinces, although the Californian elements are strongest. The Santa Cruz Mountains lie immediately to the west, and are one of the southernmost expressions of the Oregonian Province. Below are listed the commonest perennial species in the immediate vicinity of the site: (1) East-facing slope—*Acer macrophyllum* Pursh., *Aesculus californica* (Spach), *Artemisia californica* Less., *Baccharis pilularis* D. C., *Lotus scoparius* (Nutt.), *Mimulus aurantiacus* Cart., *Heteromeles arbutifolia* M. Roem., *Quercus agrifolia* Neé, *Q. douglasii* H. & A., *Q. kelloggii* Newb., *Q. lobata* Neé, *Rhamnus californica* Esch., *Rhus diversiloba* T. & G., *Ribes californicum* H. & A., *Rubus vitifolius* Cham. & Schlecht, *Salvia laris* Suksd., *Umbellularia californica* (H. & A.), *Vaccinium laris* Suksd., *Umbrellularia californica* (H. & A.), *Vaccinium ovatum* Pursh.; (2) Stream—*Alnus rhombifolia* Nutt., *Artemisia douglasiana* Bess., *Baccharis glutinosa* Pers., *Platanus racemosa* Nutt., *Salix lasiolepis* Benth.; (2) West-facing slope—*Arctostaphylos* sp.

CLIMATE

The climate is of a mediterranean type with a cool wet season and a warm dry season. During the summer months high fog occurs on many nights, while the warmest nights occur in late summer and fall after the end of the fog season. Temperature data recorded at Los Gatos during 1964 are presented on Figure 1. Los Gatos, nine airline miles from New Almaden, is only 65 feet lower in elevation and occupies a nearly identical situation at the eastern base of the Santa Cruz Mountains.

MOTHS

During the year, individuals of 205 species of moths of the families Sphingidae, Saturniidae, Nolidae, Arctiidae, Noctuidae, Geometridae, Notodontidae, Lasiocampidae, Liparidae, and Dioptidae were collected.

The seasonal occurrence of 92 species collected on five or more occasions is shown graphically by Figures 2, 3 and 4. Univoltine species are shown first in order of their seasonal appearance. The species are followed by bivoltine, trivoltine and finally, homodynamic species. Since only the first initial of the generic names is given, the appropriate species numbers from McDunnough (1938) are appended. The remainder of the species, together with earliest and latest dates of capture, are as follows:

SPHINGIDAE —

Sphinx perelegans Hy. Edw. (V-24)
Pholus achemon Dru. (V-15, IX-7)
Arctonotus lucidus Bdv. (I-16)
Celerio lineata Fabr. (IV-7, IX-26)

SATURNIIDAE —

Hyalophora euryalus Bdv. (IV-11, V-9)
Antheraea polyphemus Cram. (IV-21, VI-12)

NOLIDAE —

Celama minna Butl. (I-22, III-7)
Sarbena minuscula Zell. (I-31, III-19)

ARCTIIDAE —

Halisidota maculata angulifera Wlk. (V-13)
Estigmene acrea Dru. (IV-20, VIII-7)
Maenas vestalis Pack. (II-16, IV-20)

NOCTUIDAE —

Acronicta lepusculina felina Grt. (VII-5)
A. marmorata Sm. (VII-17, X-4)
A. impleta illita Sm. (VI-26, VII-12)
A. perdita Grt. (IV-24)
Euxoa olivia Morr. (XI-29)
E. niveilinea Grt. (X-11)
E. feniseca Harv. (X-11)
E. sponsa monteclara Sm. (VII-5, VII-12)
E. difformis Sm. (X-23)
E. henrietta Sm. (IX-27)
E. obeliscoides Gn. (IX-3)
E. excellens Grt. (X-4, XI-7)

Pseudorthosia variabilis pallidior Ckll. (IX-28, X-10)
Feltia annexa Treit (X-19)
Metalepsis cornuta Grt. (II-16)
Graphiphora c-nigrum L. (V-13)
Abagrotis trigona Sm. (VII-26, IX-10)
A. baueri McD. (X-23)
A. reedi Buckett (VII-5)
Ufeus satyricus Grt. (XII-7)
Admetovis similaris Barnes (VI-1)
Lacinipolia vicina sareta Sm. (IX-27, X-4)
Tricholita fistula Harv. (IX-28, XI-30)
Protorthodes alfkeni Grt. (IX-26, X-27)
Xylomyges cognata minorata B. & McD. (I-16, XI-30)
Stretchia inferior Sm. (I-16)
S. pacifica McD. (II-5)
Acerra normalis Grt. (III-3, IV-10)
Orthosia pulchella Harv. (III-3, XI-14)
O. ferrigera puncticostata Dyar (IV-20)
O. macona Sm. (I-17, II-19)
Perigonica angulata Sm. (IV-14, V-12)
Leucania farcta Grt. (V-10, XI-3)
Rancora serraticornis Lint. (I-10, II-5)
Cucullia dentilinea Sm. (IV-20)
Pseudobryomina fallax Hamp. (I-14, XI-22)
Behrensia conchiformis Grt. (I-16)
Apamea cuculliformis Grt. (VI-14)
A. arctica Frr. (VI-14)
A. castanea Grt. (VI-1)
Aseptis perfumosa Hamp. (VI-24, VII-11)
A. fumeola Hamp. (VII-5, VII-12)
Oligia marina Grt. (VI-14)
Procis divesta Grt. (VII-12, VIII-9)
Cerma oaklandiae B. & McD. (VIII-5, IX-20)
Agriopodes viridata Harv. (VII-11, X-10)
Amphipyra pyramidoides Gn. (VIII-7, X-19)
A. glabella brunneolatra Strand (VII-27, VIII-5)
Neperigea niveirena Harv. (VI-1)
N. albimacula B & McD. (VII-21, VIII-8)
Platyperigea extimia Wlk. (IX-18, X-4)
Proxenus mindara B. & McD. (VII-5, VIII-7)
Prodenia praefica Grt. (VI-26)
Helicoverpa phloxiphaga G. & R. (IV-20)
H. zea Boddie (IX-12, X-25)

Autographa biloba Steph. (I-16, XI-25)
Catocala aholibah Stkr. (VII-5)
C. irene Behr (VIII-26)
C. faustina Stkr. (X-4)
Caenurgina erechtea Cram. (VI-1)
C. togataria Wlk. (IX-12, XI-29)
Zale termina Grt. (V-8)
Cissusa indiscreta Hy. Edw. (III-3, III-11)
Synedoida ochracea Behr (VI-26)
S. divergens Behr (VI-16, VII-27)
Scoliopteryx libatrix L. (VI-14)
Camptylochila lubricalis occidentalis Smith (VII-25, VIII-7)
Tetanolita palligera Sm. (VI-3, VI-12)

NOTODONTIDAE —
Lophopteryx americana Harv. (IV-14)
Cerura cinerea cinereoides Dyar (IV-14, VIII-6)
C. scolopendrina Bdv. (III-14, VII-27)

GEOMETRIDAE —
Alsophila pometaria Harr. (I-16)
Nemoria delicataria Dyar (VIII-21, XI-22)
Metasiopsis granitaria Pack. (VI-23)
Scopula cacuminaria Morr. (VII-17)
S. quinquelinearia Pack. (VI-14, VI-22)
Coryphista meadi Pack. (IX-7)
Eupithecia graefi Hlst. (VI-5)
Ceratodalia gueneata Pack. (VI-24)
Stamnodes affiliata Pears. (VII-11)
Hydriomena albifasciata puncticaudata B & McD. (II-2)
H. edenata Swett (III-2)
Percnoptilota obstipata Fabr. (XI-25)
Venusia pearsalli Dyar (V-10)
Drepanulatrix carnearia Hlst. (IX-20, IX-27)
Semiothisa respersata Hlst. (VIII-9, 1X-26)
S. muscariata Gn. (VII-12)
S. excurvata Pack. (V-12, X-4)
Hesperumia sulphuraria Pack. (VII-12, VII-29)
Pteroptaea sp. (VII-11, VII-12)
Aethaloida packardaria Hlst. (VII-11, X-4)
Palaeacrita longiciliata Hlst. (I-14, XII-8)
Gabriola dyari Tayl. (X-4)
Thallophaga taylorata Hlst. (VI-22, VIII-5)
Phengommataea edwardsata Hlst. (X-11)
Synaxis hirsutaria B. & McD. (XI-11, XI-27)

Prochoerodes truxaliata Gn. (X-4, X-11)
P. forficaria Gn. (XII-4)

As can be seen by an examination of Figures 2, 3 and 4 there is a continual appearance and disappearance of species throughout the year. McFarland (1963) stated that at Corvallis, Oregon, there were seven periods during the year, each of which was characterized by a certain group of moths. Although the impressions I gained during 1964 generally agree with these divisions, the data presented do not support this theory. Perhaps a more detailed analysis using more extensive data will bear out McFarland's thesis.

As noted in an analysis of butterflies of Contra Costa County (Opler and Langston, 1968) univoltine species tend to be monophagous, while homodynamic species tend to be largely polyphagous. That this is true can be seen by an examination of Figures 2 to 4. On Figure 4 the eight species of widest seasonal occurrence are all known to be polyphagous. Additionally, all except *Pero mizon* are of considerable economic importance.

FAUNAL COMPARISON

The nocturnal "macrolepidopterous" faunae of three other locations in California and one in Oregon have been intensively studied through at least one complete season. These are as follows: (1) Santa Monica Mountains, near Beverly Hills, Los Angeles County, California, 10 years (McFarland, 1965); (2) Walnut Creek, Contra Costa County, California, six years, unpublished study by J. A. Powell; (3) Knox Mountain, 20 airline miles southwest of Alturas, Modoc County, California, four years, unpublished study by R. L. Dalleske; (4) Corvallis, Benton County, Oregon, three years (McFarland, 1963). A chart presenting the composition of the macromoth fauna of each locality by superfamily is shown as Figure 5. A triangular matrix of number of species shared in common between each site and the percent commonality with the total species of the paired localities is presented as Figure 6. Separate matrices for the Noctuoidea and Geometroidea are also presented (Figures 7 and 8).

Dice (1943) divided North America into 29 Biotic Provinces. Each of these provinces covers a considerable and continuous

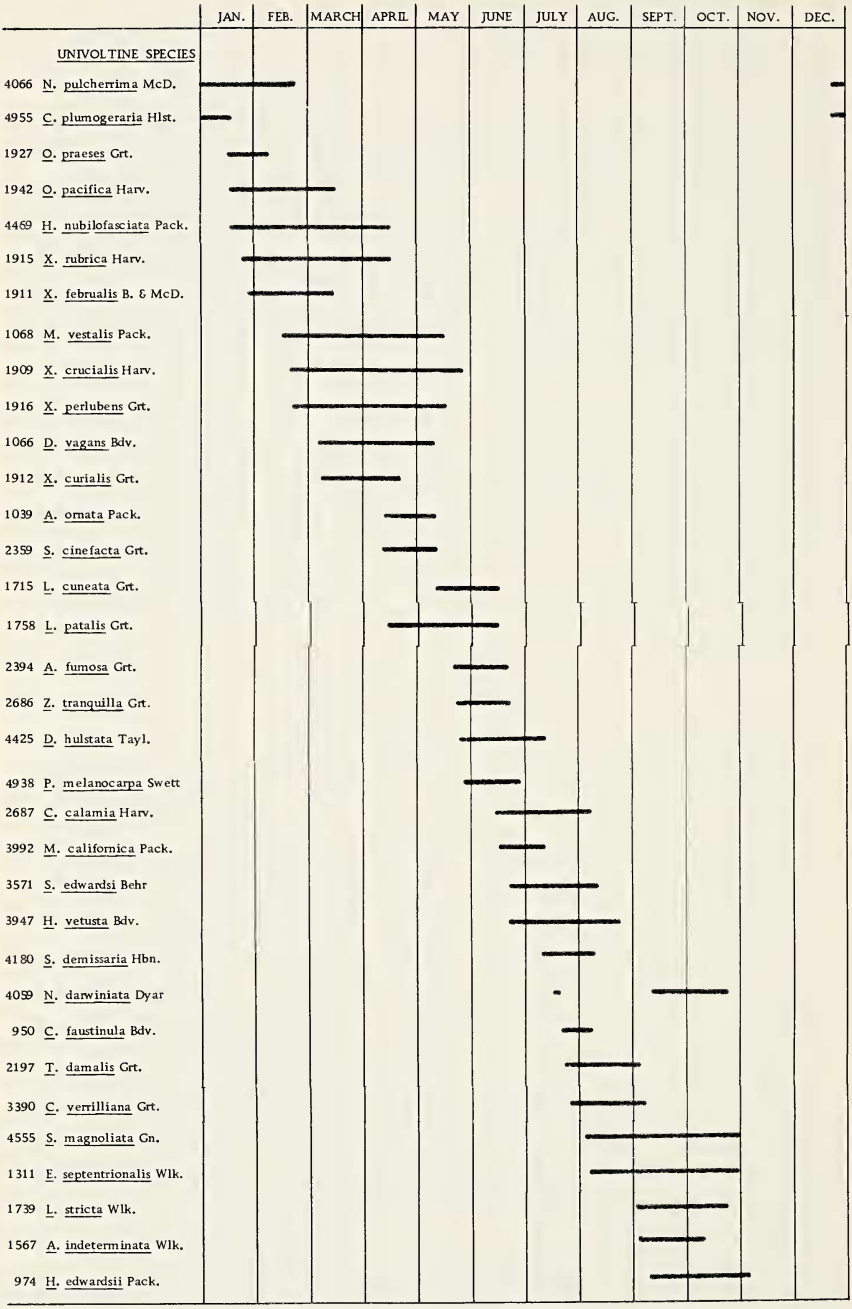
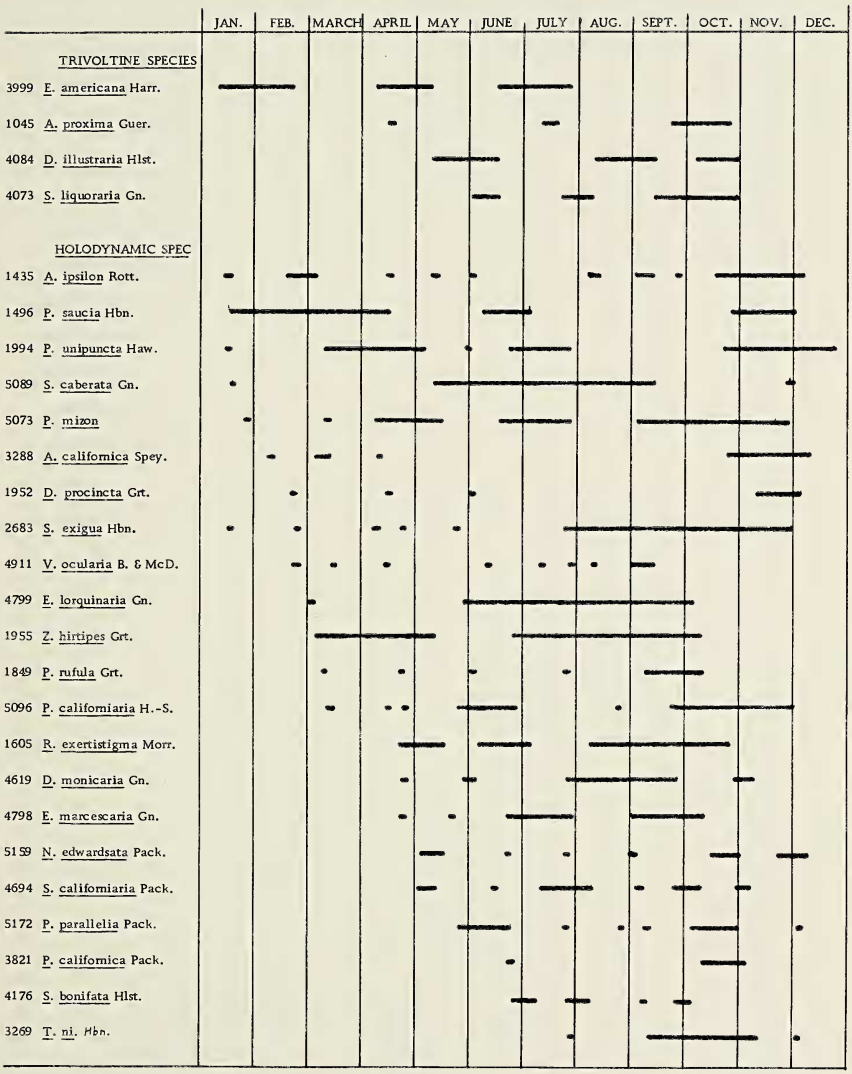
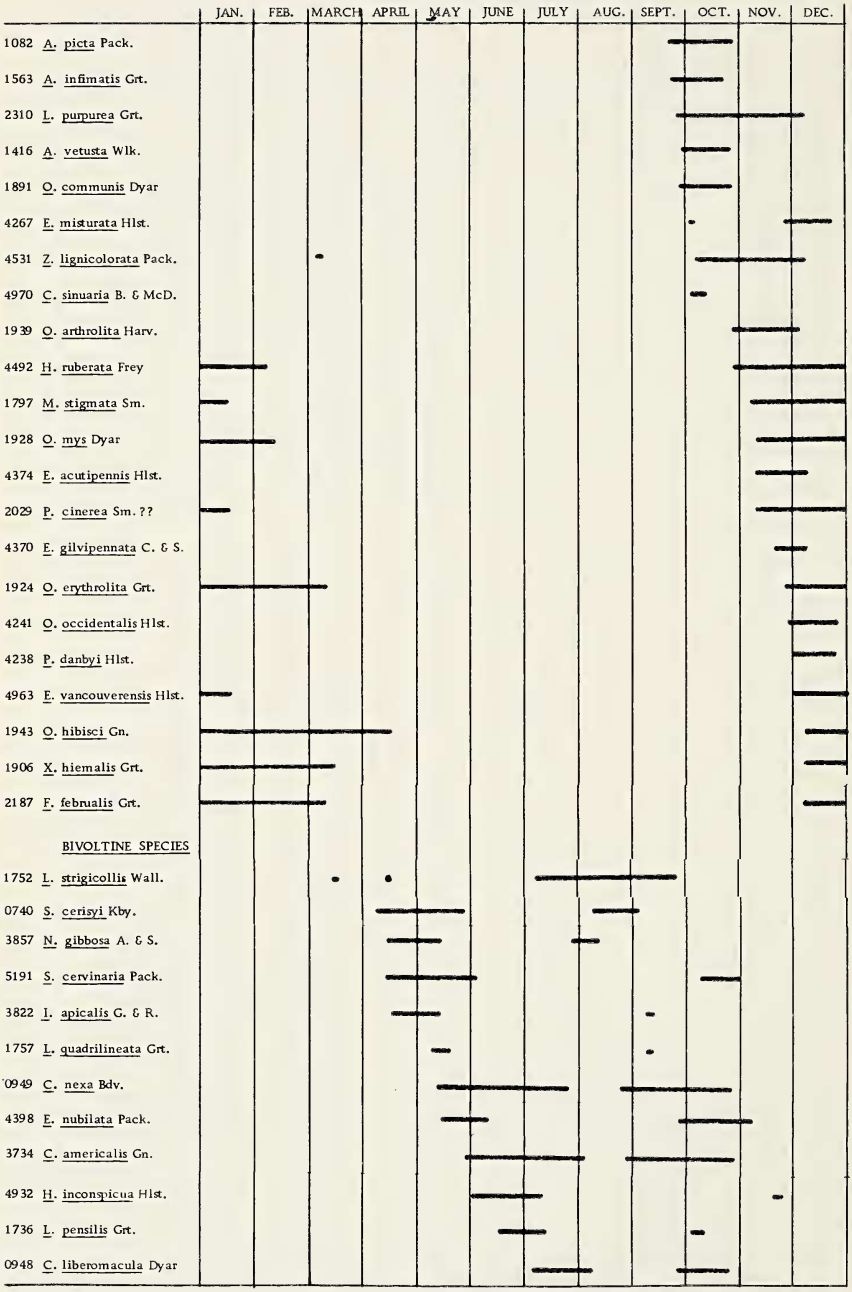


Fig. 2 to 4.—Seasonal occurrence of species collected on five or more nights at New Almaden in 1964. *Cochisea sinuaria* occurred on only three nights but was so common that it was included.


JAN.
FEB.
MARCH
APRIL
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
TRIVOLTINE SPECIES
3999 E. americana Harr.
1045 A. proxima Guer.
4084 D. illustraria Hlst.
4073 S. liquoraria Gn.
HOLODYNAMIC SPEC
1435 A. ipsilon Rott.
1496 P. saucia Hbn.
1994 P. unipuncta Haw.
5089 S. caberata Gn.
5073 P. mizon
3288 A. californica Spey.
1952 D. procincta Grt.
2683 S. exigua Hbn.
4911 V. ocularia B. & McD.
4799 E. lorquinaria Gn.
1955 Z. hirtipes Grt.
1849 P. rufula Grt.
5096 P. californiaria H.-S.
1605 R. exertistigma Morr.
4619 D. monicaria Gn.
4798 E. marcescaria Gn.
5159 N. edwardsata Pack.
4694 S. californiaria Pack.
5172 P. parallelia Pack.
3821 P. californica Pack.
4176 S. bonifata Hlst.
3269 T. ni. Hbn.


JAN.
FEB.
MARCH
APRIL
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
1082 A. picta Pack.
1563 A. infimatis Grt.
2310 L. purpurea Grt.
1416 A. vetusta Wlk.
1891 O. communis Dyar
4267 E. misturata Hlst.
4531 Z. lignicolorata Pack.
4970 C. sinuaria B. & McD.
1939 O. arthrolita Harv.
4492 H. ruberata Frey
1797 M. stigmata Sm.
1928 O. mys Dyar
4374 E. acutipennis Hlst.
2029 P. cinerea Sm. ??
4370 E. gilvipennata C. & S.
1924 O. erythrolita Grt.
4241 O. occidentalis Hlst.
4238 P. danbyi Hlst.
4963 E. vancouverensis Hlst.
1943 O. hibisci Gn.
1906 X. hiemalis Grt.
2187 F. februalis Grt.
BIVOLTINE SPECIES
1752 L. strigicollis Wall.
0740 S. cerisyi Kby.
3857 N. gibbosa A. & S.
5191 S. cervinaria Pack.
3822 I. apicalis G. & R.
1757 L. quadrilineata Grt.
0949 C. nexa Bdv.
4398 E. nubilata Pack.
3734 C. americalis Gn.
4932 H. inconspicua Hlst.
1736 L. pensilis Grt.
0948 C. liberomacula Dyar

	New Almaden (1 year)	Walnut Creek (5 year)	Santa Monicas (10 year)	Modoc County (4 year)	Corvallis, Oregon (3 year)
SPHINGOIDEA	5	5	5	6	5
SATURNIOIDEA	2	0	2	1	2
NOCTUOIDEA	134	155	168	209	198
BOMBYCOIDEA	2	4	2	5	5
DREPANOIDEA	0	0	0	0	8
GEOMETROIDEA	62	68	92	58	129
TOTAL SPECIES	205	232	269	279	345

Fig. 5.—Composition of "Macroheterocera" faunae at five localities in California and Oregon.

	New Almaden	Walnut Creek	Santa Monicas	Modoc County	Corvallis, Oregon
New Almaden	———				
Walnut Creek	36 39%	———			
Santa Monicas	35 29%	34 27%	———		
Modoc County	10 9%	10 9%	12 9%	———	
Corvallis, Oregon	28 17%	28 17%	27 14%	18 11%	———

Fig. 6.—Table showing number of species in common and percentage similarity between macromoth faunae.

	New Almaden	Walnut Creek	Santa Monicas	Modoc County	Corvallis, Oregon
New Almaden	———				
Walnut Creek	95 49%	———			
Santa Monicas	87 40%	96 42%	———		
Modoc County	52 27%	44 14%	45 14%	———	
Corvallis, Oregon	74 29%	72 26%	67 23%	58 17%	———

Fig. 7.—Similarity table for Noctuoidea.

	New Almaden	Walnut Creek	Santa Monicas	Modoc County	Corvallis, Oregon
New Almaden	———				
Walnut Creek	36 39%	———			
Santa Monicas	35 29%	34 27%	———		
Modoc County	10 9%	10 9%	12 9%	———	
Corvallis, Oregon	28 17%	28 17%	27 14%	18 11%	———

Fig. 8.—Similarity table for Geometroidea.

geographic area and is characterized by a number of ecological associations that differ from the associations of adjacent provinces. Three of the above studies, New Almaden, Santa Monica Mountains, and Walnut Creek, are located within the Californian Biotic Province. The Modoc County locality is located within the Artemisian Biotic Province; while the Corvallis, Oregon, study site is located within the Oregonian Biotic Province. By referring to Figure 6, one can see that the three Californian localities are highly correlated with each other. No pairing between any two of these localities produces a correlation lower than 35 percent. The next highest correlations are between Corvallis, Oregon, and the three Californian localities. While Corvallis has greater faunal affinities to the north and east (McFarland, 1963), a number of plants are congeneric with California plants and support nearly similar moth faunae, e.g., *Acer, Quercus, Ribes, Rhamnus, Salix, Sambucus,* etc. The Modoc County locality shows least correlation with all other sites. This is due to the strong Artemisian and montane Californian influences in its make-up.

A similar ranking of relationships but of varying magnitudes is shown by the separate matrices for Noctuoidea and Geometroidea (Figs. 7 and 8). It should be noted that correlations for noctuoids are higher than those for geometroids in all cases. This can be explained by the facts that noctuoids are more robust insects with presumably greater dispersal capabilities, and that the family contains relatively more polyphagous, polyvoltine species.

SUMMARY

During 1964, 205 species of moths of the superfamilies Sphingoidea, Saturnioidea, Noctuoidea, Bombycoidea, and Geometroidea were taken at New Almaden, Santa Clara County, California.

The seasonal occurrence of these moths is presented graphically and briefly discussed.

A comprison of the New Almaden moth fauna with those of four additional localities in California and Oregon is presented.

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